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MEDICAL MANAGEMENT OF PERIPHERAL VASCULAR DISORDERS*

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THE four chief conditions in the field of peripheral vascular disease which require the attention of the general practitioner of medicine are arterial embolism, phlebitis, arteriosclerotic disease of the arteries of the extremities, and thrombo-angiitis obliterans. I shall discuss briefly some important considerations in regard to these four conditions.

Most physicians are familiar with the fact that emboli to the extremities generally arise from diseased hearts, but apparently few of them keep this knowledge in mind when handling cardiac cases. This may explain their frequent failure to recognize promptly the occurrence of an embolism to a major peripheral artery. This complication should be anticipated in every case of acute coronary thrombosis and chronic rheumatic or arteriosclerotic heart disease and particularly in those patients in whom the hearts are fibrillating. The physician confronted with a case of heart disease of this type should at once make sure that the normal pulsations in the hands and feet are palpable, and should make a record of any pulsations which are absent. Any complaint of sudden

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numbness, coldness or pain in an extremity should at once arouse his suspicion that an embolism to a major artery has taken place. If this suspicion is confirmed by objective signs, such as loss of pulsation in the vessels, pallor and coldness of the extremity, anesthesia of the foot and muscular paralysis, he should recognize immediately that an emergency has arisen which needs prompt action on his part. It has been my observation that many times precious hours are lost when an embolism occurs, and it is not until gangrene is already beginning to develop that the family physician recognizes that a catastrophe has taken place.

An example of such delay is the following: Some months ago I was asked to see a patient by an experienced specialist in internal medicine. Two weeks previously this patient had had a severe acute coronary thrombosis following which he was desperately ill. Five days before I saw him he complained of numbness in the left foot, but because of the concentration of the physician and nurses on the cardiac problem, little attention was paid to *this* complaint. The numbness persisted and the following day the nurse noted that the foot was cold. After two more days bluish discoloration of the great toe was noted, and this development induced the attending physician to call in a specialist in peripheral vascular disease because he thought there had been a thrombosis of the dorsalis pedis artery. Up to this time no treatment had been directed toward the lower extremity. Because of the use of sedatives for the cardiac condition, the patient had not complained of pain in the leg. Examination showed the left lower extremity cold and cyanotic from the knee down. There was beginning discoloration of the great toe. There was complete paralysis of the leg muscles and complete anesthesia below the middle of the leg. The femoral pulse was present but the popliteal pulse was absent and there was no pulsation in the foot. Obviously, an embolism had lodged at the bifurcation of the common femoral artery, the most favorable location for surgical removal. After five days of delay, necrosis of the tissues was already proceeding rapidly, and it was too late to accomplish anything by medical or surgical therapy. A mid-thigh amputation was the only possible treatment, and in this patient's precarious condition, it carried a great hazard.

Your opportunity to be of greatest help to your patient is lost unless an embolism is recognized immediately after it occurs. Prompt action

should follow, and certain steps should be taken in an effort to prevent gangrene from developing.

The two most common mistakes made in the treatment of embolism are elevation of the extremity and the application of heat. Three out of every five cases of arterial embolism seen in consultation have been treated in this manner. Reflect a moment on the effect of these procedures. An extremity which suffered an embolism has been deprived of most of its blood supply. Is that blood supply increased or restored by elevating the leg? The blood pressure in the extremity distal to the point of occlusion is sharply reduced, and is scarcely adequate to force the blood to the toes. When the extremity is raised, the blood must in addition be pushed up hill. Obviously, elevation of the extremity still further impairs circulation and is harmful. The proper position for an extremity suddenly deprived of its blood supply is sloping downward. When the leg is dependent, the arterial circulation is aided by the action of gravity. The head of the bed should be raised on chairs or blocks so that the level of the feet is below that of the hips. Since the circulation is most precarious in the toes, it is an additional safeguard to turn the patient occasionally so that he lies face down with the feet extending over the end of the bed. In this position the tips of the toes are most dependent.

The second common mistake is the application of heat. The effect of warming tissues is to increase the metabolic rate and to increase the need for oxygen. When the blood supply has been suddenly cut off, these needs cannot be met, and only harm and increased pain result from heating. In many instances gangrene of the foot is due more to the improper use of heat than to the impairment of the circulation. Tissues deprived of nutrition will die, and measures are required to keep these tissues alive until circulation can be restored. It is commonplace knowledge that to preserve meat, we place it in a refrigerator, not in an oven. If we wish to preserve the tissues of an extremity until circulation has a chance to come back, we must apply cold, not heat. The simplest method is to surround the leg with covered ice bags from the toes to the knee or higher if necessary. The beneficial effect of this procedure is at once apparent in the prompt relief of pain. As circulation begins to return, the use of ice bags may gradually be discontinued.

When a major artery is suddenly blocked by an embolism, there is a marked associated spasm of all collateral arteries. Measures to relieve

this spasm are necessary to permit all available blood supply to reach the extremity. The most effective medical means of accomplishing this is by repeated intravenous injections of papaverine. The dosage used is one grain every two hours for four doses, and then every four hours until the circulation appears to be returning safely. Ampules of papaverine should be in every physician's emergency bag ready for immediate use.

Thus, the three measures which should be promptly instituted in every case of embolism are elevation of the head of the bed, the application of cold to the involved extremity, and the intravenous injection of papaverine.

A second method of relieving arterial spasm is by temporary block of the sympathetic nervous system. This can be accomplished by spinal anesthesia, paravertebral block with novocaine, or by continuous sacral anesthesia. Spinal or paravertebral block has the disadvantage that the effect wears off in less than an hour. Continuous sacral anesthesia is a better choice and is destined to be more widely used in the treatment of acute embolic episodes of the legs. If anesthetist and facilities are available this form of treatment should be started immediately.

The surgical removal of an embolism should be considered in every case. Conservative treatment for a few hours is justifiable, but during this interval surgical consultation and preparation for removal to a hospital should be carried out. Best results are obtained if embolectomy is undertaken early, which means within 12 hours after the embolism has occurred. In previous years embolectomy frequently failed because of the formation of a secondary thrombus at the site of operation on the vessel. Much more satisfactory results have been obtained since the use of anticoagulants to prevent such thrombus formation. The intravenous administration of heparin is started before operation and is continued for 48 hours. Dicumarol by mouth is started at the same time, and after 2 days the anticoagulant action of this drug is sufficient to prevent thrombosis and the heparin is discontinued. Operation can be done under local anesthesia and is not a shocking procedure. In recent years reports of successful embolectomies are becoming more frequent.

Embolism to an extremity is a greater emergency than acute appendicitis. The preservation of an extremity and the saving of the individual's life are at stake. Many of these patients succumb to an amputation of a gangrenous leg. Prompt and effective team work is

necessary to save them. Each hospital should have an embolism team consisting of physician, hematologist, anesthetist and surgeon ready to act as a group whenever this type of emergency arises.

If gangrene develops in spite of all measures taken, and an amputation becomes unavoidable, operation should be delayed as long as possible. The purpose of this delay is to allow heart function to improve and to gain time for the development of collateral circulation at the site of amputation. Since most emboli to the lower extremities stop at the bifurcations of the iliac or femoral arteries, the circulation of the thigh is impaired. Amputation is usually done through the mid-thigh region because gangrene of the leg frequently extends almost to the knee. Each day gained allows a better collateral circulation to develop in the thigh. Throughout this period the discolored portion of the extremity should be kept cold, in order to relieve pain and delay the necrotic process. The patient must be watched carefully, and signs of toxemia, such as elevation of pulse and temperature, mental confusion, attempts to get out of bed, and incontinence, should be regarded as indications for proceeding with amputation.

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The treatment of phlebitis is the second topic of this talk. Superficial phlebitis is a benign and relatively simple condition to treat. Inflammation of the superficial veins of the legs is most frequent as a complication of varicose veins, but also occurs as migrating and traumatic phlebitis. The danger of pulmonary embolism is remote as long as the patient with superficial phlebitis is reasonably active. The most common error in treatment is to keep such a patient in bed for weeks. Bed-rest is only necessary for relief of pain, and seldom is required for more than 24 hours. Warm, moist compresses during this period are helpful. As soon as possible the patient should be taught to apply an elastic bandage and should be encouraged to walk and return to normal occupation.

Phlebitis of the deep veins of the lower extremities, on the other hand, is a serious and dangerous condition, often resulting in pulmonary embolism and death, or leaving the patient permanently disabled by a swollen and unsightly leg. It is a frequent complication of operation, confinement, or illness, and should be guarded against whenever a patient is put to bed for several days for any condition. When bed-rest

becomes necessary it is the duty of every physician to make sure that several times each day the legs are uncovered and exercised for several minutes. Flexion and extension of the knees and ankles, movement of the toes, and bicycle exercises will aid circulation in the deep veins of the legs, and prevent a thrombotic process from starting in these veins. The development of a phlebitis in the deep veins of a lower extremity usually can be prevented by proper care.

In recent years it has been generally recognized that the most dangerous period of phlebitis is at the onset, when loose thrombi begin to form in the deep veins of the calf. It is during this time, when there is no swelling and physical signs are minimal, that there is the gravest danger of fatal pulmonary embolism. Complaints of pain in the legs, vague feeling of apprehension, elevation of pulse rate or temperature, tenderness of the calf muscles, pain in the calf on dorsal flexion of the foot, all should be regarded with suspicion as indicating the onset of deep phlebitis. Allen of Boston stresses that a slight simultaneous rise in temperature, pulse and respiratory rate in a previously level clinical chart is strongly suspicious of a pulmonary infarct, and should at once direct attention to a possible phlebitis in the legs.

Several American surgeons now advocate immediate ligation and division of the superficial or common femoral vein as soon as there is any suspicion of thrombosis or phlebitis in the calf veins. Credit for this bold attack on the problem goes to Dr. John Homans, and it has been carried out in hundreds of cases in the Massachusetts General and Boston Beth Israel Hospitals. Dr. Allen at the former institution insists that ligation should be done only of the superficial femoral, while Dr. Fine at the latter hospital prefers to ligate the common femoral or iliac vessels. In several cases the vena cava has been ligated. All of the Boston surgeons agree that ligation should be done in both legs, even though there is suspicion of thrombosis in only one. This is done to forestall embolism from possible thrombosis in the second leg. At the Massachusetts General Hospital prophylactic bilateral femoral vein ligations are being done on all patients over 65 who are to undergo major surgery even though there is no thrombosis or phlebitis in the legs. It is stated that femoral vein ligation results in very little, if any, persistent swelling of the legs.

Experience has shown that even bilateral femoral vein ligation is not an absolute safeguard against pulmonary embolism, for in several

cases fatal or non-fatal emboli occurred in spite of this procedure. Such emboli arise from pelvic or other veins, or from the right side of the heart. Furthermore, the statement that little, if any, persistent edema results from this operation should be accepted with reserve. To cite a single example: I recently saw in my office an unhappy young woman of 27, who gave me the following history: Last July she gave birth to her first child. Her obstetrician said nothing to her about the importance of exercising her legs during the postpartum period. Nine days later she developed severe pain in the chest and a diagnosis of pulmonary embolism secondary to phlebitis was made. Immediately, a bilateral femoral vein ligation was done. She remained in the hospital for a month with her legs constantly elevated. Ever since there had been marked swelling of both legs, which increased during the day to such an extent that her legs bulged over her shoes. She complained of constant dragging pain in the legs and fatigue due to the weight. Examination disclosed a physically perfect body except for the legs. Both lower extremities were enormously swollen, one more than the other. The measurements of the calves were 44 cm. on one side, 40 cm. on the other. The average normal measurement of the calf in a female patient of her size would be 34 cm., so that in this patient there was 10 cm., or 4 inches of swelling on the worse side, and 6 cm., or 2½ inches on the other side. These measurements were made in the morning, at a time when the swelling would be reduced by rest during the night. Similarly, her ankles measured 31 cm. and 26 cm. Normal average readings would be 23 cm. Thus, the worse ankle was 8 cm., or over 3 inches too large, while the better ankle was 3 cm., or over 1 inch swollen. The extremities were so unsightly and conspicuous that she is condemned to the indefinite use of slacks to conceal them. Perhaps this could have been avoided by the simple precaution of regular postpartum exercise of the legs. In any case it was an example of massive edema of both legs following femoral vein ligation, a condition which the proponents of this operation claim does not occur.

Opposed to the use of vein-ligation in thrombosis and phlebitis of the calf veins are those who advocate the use of anticoagulants, heparin and dicumarol. Many hundreds of cases have now been treated with anticoagulants, particularly at the Mayo Clinic, and numerous favorable reports are being published. For example, Barker and his associates of the Mayo Clinic report a series of 1000 surgical cases treated with

dicumarol. These cases were specially selected because they had already had thrombosis or embolism, or were to undergo operations in which this complication was prone to develop. Included were 180 patients who had had a non-fatal pulmonary embolism. In the entire series of 1000 patients only one fatal pulmonary embolism occurred. Such figures cannot fail to be impressive.

The great advantage of the anticoagulant method is that thrombosis and phlebitis are controlled in all parts of the body and not just in the legs. Additional operations are avoided, and the inevitable tendency to swelling of the legs from the thrombophlebitis is not aggravated by further surgical ligations. The dangers of this method of treatment are from bleeding; in wounds, in ulcerative lesions of the gastrointestinal tract, or by hemorrhage into vital organs. In the report from the Mayo Clinic previously cited, there were 25 instances of major bleeding, and 39 of minor bleeding. For the present no one should undertake to give dicumarol to a patient without the constant help and advice of a competent hematologist, who can make the necessary prothrombin time tests and who is aware of the contraindications to its use. If dangerous bleeding should occur he will be prepared to treat the patient promptly with transfusions of fresh whole blood or by injections of vitamin K.

European physicians have long been using another conservative method in treating thrombosis and phlebitis in the calf veins, and this is the application of elastic bandages from the toes to the hips while the patient is in bed. The effect of binding the legs snugly is to compress the deep veins, thereby fixing any thrombus and preventing its free movement. This method may be combined with the use of anticoagulants.

It is generally agreed that when obvious swelling of the extremity develops, the danger of pulmonary embolism is greatly diminished, and ligation of the femoral vein is no longer recommended. The purpose of treatment in this stage is to relieve pain and reduce swelling. Elevation of the extremity and the application of warm, moist compresses or dry heat have been the standard methods of treatment. These are logical and correct forms of therapy. Elevation of the leg helps to reduce venous stasis and swelling, and the application of heat tends to overcome any associated arterial spasm. Guarded exercise of the affected leg is desirable, as this is a form of physiological massage which tends to reduce swelling. It is particularly important to exercise the unaffected

leg regularly, to forestall any tendency to thrombosis and phlebitis in this leg. It is a mistake to keep patients in bed too long. As soon as pain has subsided and the temperature has become normal, an elastic bandage should be applied to the affected leg and the patient should gradually be made ambulatory. A normal sedimentation time is additional evidence that the active inflammatory process has terminated. Bed-rest beyond this point has the disadvantage that it favors development of phlebitis in the other leg.

Repeated paravertebral injections of novocaine to block the sympathetic nerves have been recommended as a form of treatment during this stage of phlebitis. It is claimed that more rapid fall of temperature, relief of pain, and reduction in swelling results from this form of treatment. The technique is relatively simple and the injections can be given at home by anesthetists familiar with the method. Unless there is some contraindication, this form of therapy is worth a trial.

Anticoagulants may properly be used in this stage of phlebitis, both to limit the thrombosis in the affected leg, and to prevent extension of the process to the other leg. I am deliberately avoiding discussion of dosage and method of administration of dicumarol lest you be tempted to use it without proper safeguards. The hematologist will know its dangers, and without his help it would be hazardous to use it.

The discussion of phlebitis thus far has been concerned with treatment of the acute phase. There remains to be considered the proper care of the later stage, which might be regarded as chronic phlebitis, but which should rather be thought of as the sequela of acute phlebitis of the deep veins. Such patients come to the physician for relief of the discomfort of a heavy, swollen, unsightly extremity. The essential cause of the persistent disability is the residual venous stasis which results from partial obliteration of the deep venous circulation. This group of patients is important from a medico-legal standpoint. Many workmen operated upon for injuries occurring during employment develop a postoperative thrombophlebitis. Not only are they disabled by the pain and feeling of fatigue in the swollen leg, but frequently recurring phlebitic ulcers require hospitalization and prolonged medical care. Such patients are a plague to insurance carriers, who must frequently pay unemployment compensation and medical bills for several years.

Treatment must be directed toward diminishing venous stasis. The three available methods are elevation of the extremity, muscular activity,

and external support. Patients who suffer from this condition should be instructed to sleep with the leg elevated, and to elevate the extremity at least to the horizontal for several periods during the day. The most effective method of keeping the leg elevated during the night is to raise the foot of the bed. During the day female patients can usually arrange household work to allow several periods of rest during which elevation of the leg can be carried out. Standing for long periods in one position or sitting with the leg dependent adds to venous stasis and should be avoided.

However, all forms of activity which cause active contractions of the muscles of the legs are beneficial and should be encouraged. Contraction of muscle has the same effect as squeezing a sponge. Local venous pressure is raised and venous return flow is accelerated. The beneficial effects are quickly noted by the patient, pain is relieved and swelling tends to be reduced. Walking, dancing, swimming, riding bicycle, playing tennis, basketball and other active games should all be encouraged. It is a common mistake for physicians to prescribe rest.

The use of elastic support, either in the form of a fitted stocking, or properly applied elastic bandage is the third of the three measures useful in this condition. Such a support acts as a resistance against which the actively contracting muscles exert pressure. The effect of the combined action is to force the venous blood out of the leg. Under the stimulus of such action, collateral venous channels develop in the deeper structures of the extremity, and a more competent venous circulation is restored.

The physician is often confronted with complications which result from the patient's failure to carry out the simple measures outlined. Such complications are dermatitis, chronic cellulitis, and ulceration of the legs. It is a frequent experience to find that patients with such lesions are treated for weeks and months without success. Various types of lotions, ointments, dyes and drugs are applied, and all types of elastic, semi-elastic and rigid bandages are employed. The quickest way to clear up such a complication is to put the patient to bed with the leg elevated. The simplest type of dressing, such as warm, moist compresses followed later by bland ointments are applied. It is seldom that more than three to four weeks are necessary to heal any such superficial lesions. Ambulatory treatment of such cases should be avoided. It is expensive, time consuming, and frequently futile, and the chief result is damage to the physician's reputation.

Turning now to our third topic, the management of patients with arteriosclerotic peripheral vascular disease, we face the largest problem in this field. The many causes of arteriosclerosis, age, diet, hypertension, diabetes, gout, endogenous and exogenous poisons, are causing a constant increase in cases of this type. Most patients come to the physician because of increasing limitation in the ability to walk, but many seek aid because of rest-pain, ulceration or gangrene of the toes or feet.

The simplest type of case is the patient whose only complaint is that he must stop every block or two because of recurring pain in the calf or foot. Such a patient presents a general and a local problem. The symptoms in his leg are due to arteriosclerosis which is part of a generalized disease. What factors are responsible for the arteriosclerosis and what can be done about it? A careful history and complete physical examination may reveal an unsuspected hypertension or sugar in the urine due to uncontrolled diabetes. Tophi in the ear lobes may point to gout. Xanthomatous skin lesions will suggest a high cholesterol in the blood. A history of syphilis may be obtained. The patient may be forty or fifty pounds too heavy, revealing lack of judgment or understanding about eating habits. The careful physician will follow through any clues obtained as to the cause of the premature arteriosclerosis, and will supplement his physical examination with appropriate laboratory studies. He will then be in a position to advise his patient in regard to diet, change in living habits, and specific care of recognized illnesses, all of which are part of the intelligent treatment of his case.

The local problem is relief of the pain in the legs which occurs on walking. This can be solved only by measures which increase the circulation in the extremities. Patients who use tobacco must be convinced that it is necessary to give up this habit completely. Wide experience in the treatment of individuals with arteriosclerotic peripheral vascular disease has demonstrated that smoking aggravates this condition, and that cessation of smoking results in clinical improvement.

The most common error made by physicians in treating patients with this type of peripheral vascular disease is to advise them to spare their legs and walk as little as possible. Physiologists are all agreed that the active use of a muscle results in increase of its blood supply. The end products of cellular activity such as lactic acid and histamine are powerful vasodilators, and their local effect is to increase circulation. Therefore, it may be said that by activity the patient manufactures in

his muscles the most potent medicine which can help his circulation. It is my custom to recommend graded activity of many kinds to patients with intermittent claudication. They are particularly encouraged to walk at a leisurely pace from one to three miles daily, stopping whenever necessary for a few minutes to relieve pain. Walking is advised to and from work, and on every occasion when it is necessary to go from one place to another. Such activities as dancing, playing golf and riding a bicycle within reasonable limits are approved. It is a common experience to have patients report that as they continue to walk they are able to go further and further distances without pain. Considerable time may be required to carry out such activity but the persistent patient will be rewarded by steady improvement in walking.

The use of heat has an important place in the treatment of arteriosclerotic peripheral vascular disease. General heating of the body causes the peripheral blood vessels to dilate, bringing more blood to the extremities. The local effect of heat is to increase the metabolic activity of the cells resulting in increased production of lactic acid and histamine. These are active vasodilators which aid in increasing local circulation. Thus, both general and local heating have value.

The simplest, safest and cheapest form of heat therapy is the warm tub bath. It combines the benefits of both general and local heating. Patients should be instructed to take tub baths at body temperature for one-half to one hour once or twice daily. A pound of epsom or sea salt should be added to each bath as this tends to lessen skin irritation.

Dry heat applied with a baking apparatus or by diathermy is also valuable, but care must be used to avoid over heating. When tissues poorly supplied with blood are heated to over 100° F. burns frequently result. Furthermore, heat is effective in direct relation to the period used. A temperature between 90° and 95° F. maintained for several hours is an effective and safe form of treatment. Such treatment is best given during the night when the patient is normally inactive. For this purpose a specially constructed heater regulated by a thermostat is employed. Such apparatuses are relatively inexpensive and are available. Sleeping under such a heater gives the patient an effective eight hour heat treatment every night.

The value of drugs in the treatment of arteriosclerotic peripheral vascular disease has not been established. As in the treatment of coronary sclerosis, the use of theobromine or aminophyllin combined with

phenobarbital is recommended, although evidence that benefit results is difficult to establish. Potassium iodide is given in combination with these, and all three drugs are best prescribed in enteric-coated pills or capsules. Individual tolerance varies a good deal and the dosage must be adjusted to each patient.

Injections of various expensive biological products such as pancreatic extract (depropanex), testosterone, and tetrathione are highly recommended by their manufacturers, but there is little scientific evidence to support their claims. For the patient whose only complaint is intermittent claudication, their use will be disappointing. The same can be said about the use of the expensive suction-pressure glass boot and the other types of apparatus which employ the same principles.

It is important that the general practitioner should take an optimistic attitude toward the possibilities of improvement in patients with arteriosclerotic peripheral vascular disease, and he will find that his optimism is justified. Much harm is done to the morale of patients by professional pessimism. In the treatment of patients with peripheral vascular disease, just as in those with acute illnesses like pneumonia and typhoid fever, it is well to remember that nature is on the side of the doctor, and considerable spontaneous improvement may take place. Collateral circulation gradually develops to take the place of occluded vessels in many patients. When, in addition, the few simple methods outlined are faithfully carried out, improvement will result in a surprisingly large number of cases.

It is useful to point out briefly the value of hypertension in patients with peripheral vascular disease. In general, it may be stated that high blood pressure tends to protect such patients from serious complications. When sudden occlusion of a major extremity artery occurs due to thrombosis or embolism, gangrene is less likely to take place when the blood pressure is elevated than when it is low. I have frequently observed that in patients with peripheral vascular disease the circulation in the legs tends to improve if hypertension develops. On the contrary, when patients with impaired circulation in the legs and long standing high blood pressure suffer a coronary thrombosis, the associated fall in pressure may precipitate gangrene of the foot.

When arteriosclerotic peripheral vascular disease reaches the stage of ulceration or gangrene, the problem becomes much more difficult. Pain is present not only during activity, but also at rest, and may be

severe. The local destructive process may be progressive and the loss of the extremity is frequently threatened. The serious nature of the lesion must be recognized, and the patient should be confined to bed. When necessary, crutches should be used to avoid weight bearing on the affected foot. The head of the bed should be elevated to aid the flow of blood into the lower extremities. Pain must be relieved by medication, and aspirin, codeine, and morphine may be necessary. Sometimes small intravenous injections of typhoid vaccine to produce slight febrile reactions may be used to relieve pain. The local use of heat frequently aggravates pain, and it should then be discontinued. Instead, local cooling with covered ice bags may give relief. Occasionally, methods to produce venous stasis, such as ligation of the femoral vein or the application of an intermittent venous occlusion apparatus has value in aiding the healing of ulceration.

The diabetic patient with advanced arteriosclerotic peripheral vascular disease presents a special problem because of his susceptibility to infection. In such patients gangrene may develop and involve only a portion of one toe. If such a limited area of gangrene can be kept free from infection, spontaneous demarcation and separation of the necrotic tissue may take place, and loss of the extremity may be prevented. However, unless meticulous attention to detail is observed, infection readily takes place at the junction of living and necrotic tissues, and quickly travels along tendon sheaths or lymphatic channels. Immediately, what appeared to be a minor trouble, suddenly threatens the loss of the patient's leg and may cost him his life. Particularly in the patient with diabetes, any local ulcerative or gangrenous lesion should be treated seriously. Weight bearing must be strictly forbidden, smoking must be stopped, the diabetes must be carefully controlled so that there is no glycosuria, the local lesion must be carefully sterilized and covered with an adequate sterile dressing, and measures to improve the circulation must be instituted. In addition, penicillin should be used locally and given by injection as a safeguard against spreading infection. If for any reason penicillin cannot be used sulfadiazene should be given in adequate dosage.

If conservative treatment results in evidence of improvement, it should be continued, but failure of improvement to take place after several months should be bravely recognized by both physician and patient. There is no greater mistake than to continue futile conservative

treatment in a patient with spreading gangrene until his general condition deteriorates to the point where he cannot survive an amputation. Yet such tragic mistakes in judgment are frequently seen. While the loss of an extremity cannot be regarded lightly, it is still possible for a patient to adjust himself to it and lead a comfortable and fairly active life.

When amputation becomes necessary the level of operation requires serious thought. In most cases local operations to remove one or more toes, or a portion of the foot, will fail. Usually, gangrene of the operative wound promptly develops and spreads, and a higher amputation becomes necessary. Most surgeons recommend amputation through the lower part of the thigh. Satisfactory healing at this level can always be anticipated, but the loss of the knee joint adds greatly to the patient's disability. In most instances amputation can be performed through the middle of the leg, saving the knee joint and about six inches of the leg. A guillotine type of operation leaving the wound wide open for drainage is usually employed. An artificial leg can be fitted to such a stump and the patient can then walk very well steadied by the use of his own knee joint. The operative mortality is much lower when amputations are done through the leg instead of the thigh, and the resulting stump is seldom painful. Recently, the published figures of many of the large hospitals of New York, Philadelphia and Boston, reporting the mortality after thigh amputations were summarized: Of 637 diabetic patients subjected to mid-thigh amputation, 300 died, a mortality of 47 per cent. In contrast, in 110 unselected diabetic patients treated by mid-leg amputation by myself or under my direction, there have been only 8 deaths, a mortality of 7 per cent. In view of the many advantages, I have been recommending mid-leg amputations in nearly all cases for several years.

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The final subject of this talk is the treatment of thrombo-angiitis obliterans. The first symptom of this condition may be an attack of superficial phlebitis, or pain in a toe which is mistakenly attributed to an ingrown toe nail, or pain in the calf muscles on walking a few blocks. With progression, these symptoms become intensified, and later ulceration or gangrene of the toes may develop. Finally, the spread of gangrene and persistent pain may lead to amputation of the leg. This curious disease has been steadily increasing in frequency during the past fifty

years, and cases may be encountered in any general practice. It is a condition which occurs in young individuals, chiefly between twenty and forty years of age. Ninety-nine per cent of the patients are male, but typical examples are occasionally seen in females. All nationalities and races are affected. The use of tobacco by individuals susceptible to this substance causes the disease.

A patient with thrombo-angiitis obliterans must be persuaded to give up smoking completely and permanently. It is useless to treat him unless he coöperates wholeheartedly in this respect. Many patients continue to smoke in spite of repeated warnings that it will result in the loss of a leg. In part, this is due to unwillingness to believe that they have a special susceptibility to tobacco which most people do not share. In part, it is due to the attitude of physicians who disparage the advice of experts in this field and suggest that it will be sufficient to *reduce* the amount of smoking. When gangrene finally develops it is frequently too late to prevent loss of the extremity. The most important part of the treatment in an individual who has thrombo-angiitis obliterans is to make certain that he has absolutely stopped smoking.

Since most patients with this disease are young, considerable spontaneous improvement in circulation often results when the etiologic factor is removed. To speed up the return of circulation, many methods of treatment are available and some of them were outlined in discussing the treatment of arteriosclerotic peripheral vascular disease. However, the most effective treatment is the repeated intravenous injection of hypertonic salt solution. The technique of saline injections is as follows: The solution used is 5 per cent sodium chloride. It is prepared in freshly distilled water, filtered, and immediately sterilized. Since bacteria grow rapidly in distilled water, immediate sterilization is important to avoid contamination. If injections are followed by chills or temperature reaction, the cause is almost always found in failure to follow this rule. Injections are given by the gravity method into a superficial vein at the elbow. Occasionally, when the arm veins are very small, the external jugular vein is employed. The initial dose is 150 cc. and all subsequent injections are 300 cc. The fluid is allowed to run in fairly quickly, only about ten minutes being required for the injection. During this time patients are kept lying flat. While the treatments are being given, patients become very thirsty and many of them experience a sensation of warmth. They are allowed to get up as soon as the injections are fin-

ished and may return to work. One of the great advantages of this method of treatment is that it is ambulatory and it does not interfere with employment. The injections are at first given on alternate days three times a week, later twice a week, and the length of intervals is further increased as the patients improve. The total duration of treatment varies from six weeks to two years, depending upon the severity of the individual case. Patients are discharged when all symptoms have disappeared or when the maximum possible improvement has been obtained.

Patients with ulceration or gangrene require bed rest, and in such cases pain may be severe. If codeine or small doses of morphine fail to relieve pain, repeated intravenous injections of typhoid vaccine sufficient to produce mild fever may be more effective. Care should be used to avoid temperatures higher than 101 degrees, as excessive fever may induce further thrombosis. Occasionally, severe and persistent pain requires more energetic treatment, and in such cases exposure and section of the sensory nerves of the foot is immediately and completely effective. The nerves to the foot can be exposed by short vertical incisions just above the ankle. The nerves are sectioned and immediately sutured. By this means complete anesthesia of ulcerated areas can be produced, and such anesthesia will last for six months to a year. During this period the ulcers can be cleaned and dressed without pain, and they will usually be healed before sensation returns. By dividing the nerves low down in the leg, fibers going to the calf muscles are spared, and there is no interference with muscular activity and walking. Trophic changes in the foot do not occur, and healing of ulcerations appears to be accelerated. This operation should not be undertaken until other methods have been tried without success. Operations done in tissues with poor blood supply may result in poor healing and further complications.

More than 900 patients have now been treated during the past twenty-three years by intravenous injections of 5 per cent saline solution. Of this number over 800 have improved under treatment, and in the great majority of them treatment is no longer necessary. A careful follow-up record has been kept. Most of them are known to be in good health and are working at various occupations. No patient restored to good condition has ever had recurrence of trouble or required amputation unless he resumed smoking. In the entire group of 910 patients only sixty amputations have been necessary, 6.6 per cent. These were re-

quired only in those patients who were first seen at a stage when extensive ulceration or massive gangrene was already present, or in those who could not be induced to refrain permanently from smoking. If thrombo-angiitis obliterans were always recognized and treated in its early stages, and if patients coöperated by ceasing the use of tobacco when instructed to do so, amputations for this disease could be absolutely eliminated.

When conservative methods fail and amputation is required, the knee joint should always be saved. Since most patients with thrombo-angiitis obliterans are young men who must continue to earn a livelihood, it is particularly important to reduce disability. With an amputation below the knee, a young man can soon walk on an artificial leg without a perceptible limp, and he has no difficulty in finding employment. Amputation above the knee is seldom justified in a patient with this disease.

Many other problems in peripheral vascular disease have not been discussed. These include varicose veins, Raynaud's disease, other types of vasomotor disturbances, and various forms of lymphedema. I have concentrated on the four most common conditions to lessen confusion and to leave with you a few clear principles of treatment.